



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification<sup>6</sup>:

A21C 11/16, 11/18, 11/20

A1

(11) International Publication Number:

WO 95/31108

(43) International Publication Date: 23 November 1995 (23.11.95)

(21) International Application Number: PCT/US95/05553

(22) International Filing Date: 10 May 1995 (10.05.95)

(30) Priority Data:

08/241,321	11 May 1994 (11.05.94)	US
08/353,477	9 December 1994 (09.12.94)	US

(60) Parent Applications or Grants

(63) Related by Continuation

US	08/241,321 (CIP)
Filed on	11 May 1994 (11.05.94)
US	08/353,477 (CIP)
Filed on	9 December 1994 (09.12.94)

(71) Applicant (for all designated States except US): GENERAL MILLS, INC. [US/US]; Number One General Mills Boulevard, P.O. Box 1113, Minneapolis, MN 55440 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): WEINSTEIN, James, N. [US/US]; 2628 Emerson Avenue South, Minneapolis, MN 55408 (US). TOLSON, Scott, A [US/US]; 1321 Wyncrest Court, Arden Hills, MN 55112 (US). HUBERG, Peter, A. [US/US]; 214 Oak Hill Drive, Shoreview, MN 55126 (US).

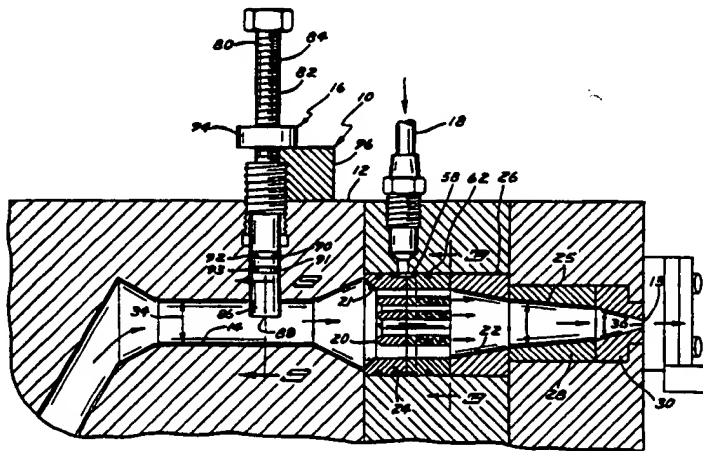
(74) Agents: O'TOOLE, John, A. et al.; General Mills, Inc., MGO-4SE, P.O. Box 1113, Minneapolis, MN 55440 (US).

(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG).

Published

*With international search report.**Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.*

(54) Title: APPARATUS AND METHODS FOR MAKING MULTIPLE, COMPLEXLY PATTERNED EXTRUDATES



(57) Abstract

Apparatus (10) and methods are disclosed where plastic extrudable food product is provided such as by a food cooker extruder (12) and is mixed with a food color to form a complexly patterned food product, such as by a pattern forming die (20). The cross-sectional area of the patterned food product is reduced from an inlet end (34) to an outlet end (36) by a factor of at least 50:1 at an average convergence angle of  $\leq 45^\circ$  while maintaining the cross-sectional pattern to form a reduced cross-sectional patterned dough, and then is extruded through a die port having an opening equal to the reduced cross-sectional area to form a complexly patterned extrudate. In the preferred form, multiple extrudates are simultaneously formed with the flow rates for each extrudate being adjustable by an adjuster plug (16) including a smooth cylindrical portion (86) extendable into a passageway (14) having a circular cross section of a larger diameter than the cylindrical portion (86). In a preferred form, the extrudates are extruded in a non-circular pattern and specifically in a horizontal, single plane by a manifold (100) including ports (134, 136) and ducts (132, 138) receiving flow from passageways (128, 130) receiving flow from conduits (116, 118, 120) receiving flow from the food cooker extruder (12).

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

-1-

1           Apparatus and Methods for Making Multiple,  
              Complexly Patterned Extrudates

1. Field of the Invention

*Ind 2*  
5           The present invention comprises apparatus and methods  
for making complexly patterned multicolored extruded food  
products. More particularly, the present invention  
relates to apparatus and methods for reducing a large  
cross sectional area complexly patterned food extrudate to  
a smaller area while maintaining the complex pattern, to  
10 apparatus and methods for adjusting flow of plastic  
extrudable food product, and to a manifold for making  
multiple extrudates formed of plastic extrudable food  
product and having uniformity of flow.

2. Background

15           Food products such as Ready-To-Eat ("R-T-E") cereals  
and snack products vary widely in composition, shape,  
color, flavor, texture, etc. Such products can include  
both puffed and unpuffed varieties. One attractive  
feature is their appearance which can include specific  
20 attributes such as shape and coloration. Especially  
attractive are products having a complex but organized  
pattern of coloration, shape and/or complex shape.

          A wide variety of techniques are known to provide  
complexly shaped products such as rings, stars, letters,  
25 figures, etc. Problems generally include how to provide  
consistently the desired degree of shape detail or  
resolution in the finished pieces. Similarly, for colored  
products, a problem is how to consistently provide a fine  
level of detail. This problem of imparting a fine level

-2-

1 of detail is particularly difficult in the provision of  
complexly patterned R-T-E cereals due to their generally  
smaller size. The problem is even more severe for puffed  
R-T-E cereal products due to the very tiny size of the  
5 pellets that are expanded to form the finished products.  
Of course, the pellets must contain and retain the complex  
pattern.

In particular, it would be desirable to prepare puffed  
R-T-E cereals having a shape and color pattern reminiscent  
10 of various sports balls such as baseballs, footballs,  
basketballs and soccer balls, such as are disclosed in 1)  
USSN 014,233, filed October 18, 1993 by Laughlin et al.  
entitled Food Product Piece, 2) USSN 014,068, filed  
October 12, 1993 by Laughlin entitled Food Product Piece,  
15 3) USSN 014,474, filed October 22, 1993 by Laughlin  
entitled Food Product Piece, and 4) USSN 014,069, filed  
October 12, 1993 by Laughlin entitled Food Product Piece,  
respectively, each of which are incorporated herein by  
reference. Such products are characterized in part by  
20 high degrees of resolution such as by line features (such  
as to indicate traditional sticking patterns) 1mm> in  
thickness and even 0.5 mm>. Providing a cereal pellet  
which upon puffing provides a puffed R-T-E cereal  
exhibiting such a fineness of detail is a difficult  
25 problem to overcome.

Line colored or externally striped food products such  
as R-T-E cereals as well as apparatus and methods for  
their preparation are described in U.S. 2,858,217 entitled  
Cereal Product With Striped Effect and Method of Making  
30 Same (issued Oct. 28, 1958 to J. O. Benson) and which is  
incorporated herein by reference. The '217 patent  
describes an extrudate extruder having a color injecting  
die insert for making a complexly patterned extrudate.  
However, the extrudate is directly extruded without any  
35 reduction in its cross sectional area. Also, the method  
appears to be limited to producing only flakes in a simple  
pattern of generally parallel more or less straight lines.

- 3 -

1 The method is not capable of generating a direct expanded cereal or snack (i.e., expanded directly from the extruder) having a line detail of such a degree of fineness.

5 An improvement or modification in the technique for providing a line colored cereal based snack piece is described in U.S. 3,447,931 (issued June 3, 1969 also to Benson et al.) entitled Process For Preparing a Puffed, Concave Shaped Cereal Product. More particularly, the '931 patent describes a process for making a cup flower  
10 shaped R-T-E cereal piece having a complex line pattern. The process involves extruding a plurality of rope dough filaments which are pressed together to form a column or rope without a material decrease in the cross section which is then combined under conditions such that no  
15 puffing occurs. The composite strand of compressed filaments is then cut into wafers and which are subsequently heat puffed. While useful, the process appears to be limited to producing only the "flower bloom" shape. Also, the pieces prepared are of a larger snack  
20 piece size rather than the relatively smaller pieces characteristic of R-T-E cereals.

Especially in commercial applications, the plastic extrudable food product is supplied in an amount to form a plurality of extrudates. Problems then arise that  
25 extrudates have uniformity of flow for consistency in the final product, with adjustment of the flow rate and pressure being accomplished without increasing the likelihood of downstream plugging. Furthermore, problems also arise that the extrudates interfere with each other  
30 such as by falling on top of each other thereby making downstream processing difficult.

In a first aspect, the present invention provides an improvement in apparatus and methods for preparing food products characterized by at least two colors in an  
35 organized pattern. In particular, the present invention provides an improvement in the degree of fineness level of color detail (1mm>) even on food products such as pellets

-4-

1 for puffed R-T-E cereals that are very small (e.g., 3 to  
6 mm) in diameter.

In a further aspect, the present invention provides an  
improvement in apparatus and methods for adding additives  
5 in flowing dough. In particular, the additives are added  
in interstitial gaps imparted in the flowing dough, with  
portions of the interstitial gaps being filled upstream  
of the addition of the additives to prevent the additives  
flowing into those portions. It is an aim of the present  
10 invention to prevent a disproportionate amount of  
additives from being on the outside of the flowing dough.

In a still further aspect, the present invention  
provides a flow rate adjustment apparatus for adjustment  
of plastic extrudable food flow. In particular, the  
15 present invention provides an improvement that the flow of  
dough is not stopped or allowed to build up which can lead  
to hardening of the dough, with hardened dough potentially  
causing plugging problems downstream.

In another aspect, the present invention provides a  
20 manifold where the extrudates are located in a non-  
circular pattern avoiding the problems of individual  
extrudates interfering with each other and allowing  
easier placement on horizontally arranged conveyors. In  
particular, the present invention provides an improvement  
25 that the extrudates are in a horizontal pattern in a  
single plane.

#### BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is an end view partially cut away of the die  
face of a food cooker extruder showing a plurality of exit  
30 ports.

Figure 2 is a sectional view greatly cut away of a  
reduction passageway of the present invention taken along  
lines 2-2 of Figure 1.

Figure 3 shows an enlarged sectional view of a die  
35 insert for making an enlarged complexly shaped dough taken  
along lines 3-3 of Figure 2.

-5-

1        Figure 4 is an enlarged sectional view of a die insert showing the channels for the food color flow taken along lines 4-4 of Figure 3.

5        Figure 5 is an enlarged sectional view of the die insert taken along lines 5-5 of Figure 4 in an upstream orientation.

      Figure 6 is an enlarged sectional view of the die insert taken along lines 5-5 of Figure 4 similar to Figure 5 but showing a downstream orientation.

10       Figure 7 is an enlarged plan view of a finished puffed complexly patterned R-T-E cereal piece prepared using the present methods and apparatus.

      Figure 8 is an enlarged sectional view of the R-T-E cereal piece taken along lines 8-8 of Figure 7 showing the  
15       concave shape of the cereal piece.

      Figure 9 is a partial sectional view of the food cooker extruder taken along lines 9-9 of Figure 2.

      Figure 10 is a front elevational view of a manifold for making multiple extrudates secured to the outlet of a  
20       food cooker extruder.

      Figure 11 is a partial cross-sectional view of the manifold taken along lines 11-11 of Figure 10.

      Where used in the various figures of the drawing, the same numerals designate the same or similar parts.

25       Furthermore, when the terms "top," "bottom," "first," "second," "upper," "lower," "height," "width," "length," "end," "side," "horizontal," "vertical," and similar terms are used herein, it should be understood that these terms have reference only to the structure shown in the drawing  
30       and are utilized only to facilitate describing the invention.

#### DESCRIPTION

      Referring now to the drawing and briefly in particular to Figure 1, there is shown an apparatus for preparing a  
35       complexly patterned cereal dough piece according to the preferred teachings of the present invention that is generally designated 10. In the most preferred form,

-6-

1 apparatus 10 generally includes a means for providing at least one extrudable food product or cooked cereal dough such as a cooker extruder 12 as seen in Figure 1.

Extruder 12 is seen to have at least one, and more

5 preferably a plurality of, exit ports or orifices 13 each for extruding of a complexly patterned cooked cereal dough of the present invention (not shown) or other extrudable food product.

While a cooker extruder is the preferred equipment to  
10 provide the extrudable food, other conventional equipment and techniques can also be employed. For example, a batch cooker or semi-continuous cooker for cooking the ingredients in bulk can be equipped with dough forming and conveying extruder element. In other embodiments, e.g., a  
15 low moisture fruit paste, a simple screw conveyor can be employed. While in the present description particular reference is made to the provision of complexly patterned farinaceous materials such as R-T-E cereals and snack products, the skilled artisan will appreciate that the  
20 apparatus and techniques can be employed with a wide variety of extrudable food products, especially such plastic foods as low moisture fruit products.

Now referring to Figure 2, the cooker extruder 12 provides the cooked cereal dough in quantity which can  
25 supply one or preferably, especially in commercial applications, a plurality of passageways 14, each leading to an exit port 13. In highly preferred embodiments, the apparatus 10 can additionally include a means for adjusting the cooked cereal dough flow rate and pressure  
30 such as the adjustably retractable dough flow adjuster plug 16 depicted. Such a flow rate adjustment means is particularly useful when, as in the embodiment depicted, the extruder supplies a large number of extrudate orifices. Absent such a flow rate adjustment means, the  
35 particular extrudate characteristics (e.g., pressure, mass flow) from each of so many orifices are difficult to

-7-

1 control since the length of passageway 14 from the central  
supply can vary.

Flow adjuster plug 16 can include a rod or bolt 80  
having at least upper and lower cylindrical portions 84  
5 and 86. Upper portion 84 in the most preferred form  
includes threads 82. Lower cylindrical portion 86 is in  
the most preferred form of a plug having a smooth outer  
periphery of a diameter which is less than the diameter  
of passageway 14. Further, the inner axial end 88 of  
10 portion 86 opposite to portion 84 has a generally flat  
configuration and specifically has a diameter which is  
considerably larger than the diameter of passageway 14.  
Extruder 12 has a cylindrical bore which intersects  
generally perpendicular with passageway 14 and which  
15 includes a radially outward, threaded portion and a  
radially inward, smooth portion having a diameter  
generally equal to and for slideable and rotatable receipt  
of portion 86 such that the center line of portion 86 is  
generally perpendicular to the center line of passageway  
20 14. Bolt 80 further includes a threaded portion located  
intermediate portions 84 and 86 of a size for threadable  
receipt in the extruder bore. Plug 16 further includes  
a means for sealing against dough of extruder 12 leaking  
from passageway 14 such as at least a first "O" ring 90,  
25 91 inset into a receiving peripheral seal groove 92, 93,  
respectively. Plug 16 can further include lock nut 94  
threaded on threads 82 of portion 84 and which can be  
tightened against block 96 to secure bolt 80 against  
movement such as caused by vibration of extruder 12.  
30 By rotating bolt 80 into or out of the extruder bore,  
portion 86 can be adjustably retractably extended into  
passageway 14. It can then be appreciated that the area  
of flow through passageway 14 at plug 16 is inversely  
related to the extent that portion 86 extends into  
35 passageway 14. It should be appreciated that portion 86  
can not choke or stop dough flow through passageway 14 or  
provide a buildup location for dough in passageway 14.

-8-

1 In particular, due to the smaller diameter of portion 86  
than passageway 14, the outer extent of portion 86 will  
extend along a chord of the circular cross section of  
passageway 14 at a spacing from its center less than its  
5 radius allowing flow of dough therebetween. It should be  
appreciated that due to the circular cross sections of  
portion 86, dough will tend to flow around portion 86  
through passageway 14 and not stop in front thereof such  
as can occur if a flat or other non-cylindrical surface  
10 were presented. Likewise, when portion 86 is fully  
retracted out of passageway 14, the extruder bore does not  
form locations outside of passageway 14 in which dough can  
accumulate. Further, due to the preferred shape of end 88  
relative to passageway 14, even if bolt 80 were rotated  
15 such that end 88 engaged the wall in extruder 12 defining  
passageway 14, end 88 does not closely mate passageway 14  
but will similarly generally extend along a chord of the  
circular cross section of passageway 14 at a spacing from  
its center less than its radius allowing flow of dough  
20 therebetween. Stopping dough flow or allowing dough  
buildup or accumulation can lead to hardening of the  
dough, with hardened dough potentially causing plugging  
problems downstream. In the most preferred form, with end  
88 engaging the wall in extruder 12 defining passageway  
25 14, portion 86 covers less than 90% of the cross-sectional  
area of passageway 14 allowing flow of dough through at  
least 10% of the cross-sectional area of passageway 14 at  
all times.

The apparatus 10 further essentially includes at least  
30 one food color supply 18 which can supply a flowable  
colored food material such as food color liquid (whether  
oil or preferably water based). The color supply 18 is in  
fluid communication with and the apparatus 10 further  
includes a means for mixing or forming the food color  
35 liquid and extrudable food product into a complexly  
patterned food extrudate such as a greatly enlarged

-9-

1 (relative to the exit orifice) pattern forming die insert  
20 depicted. In the preferred embodiment, the passageway  
14 can include a first flared or divergent portion 21  
immediately upstream of the die insert 20 to widen the  
5 passageway 14 to an equal diameter to the die insert 20 as  
well as a second convergent flared portion 22 downstream.  
In the drawing, the passageway 14 and other constituent  
elements are depicted in close to actual size. Thus, the  
diameter of the die insert 20 is about 30 mm and is  
10 positioned within a slightly enlarged portion 24 of  
passageway 14. As a result, the diameter of the  
complexly patterned dough extrudate as it exits the die  
insert 20 will have an enlarged initial diameter about  
30 mm. Of course, other sizes for the die insert 20 can  
15 be used (e.g., 15 to 100 mm).

In Figure 2, it can be seen that the complexly  
patterned dough extrudate so formed then moves through by  
pressure flow and apparatus 10 further includes a means  
for reducing the cross sectional area of the complexly  
20 patterned food extrudate while maintaining the pattern  
such as a reducing or necking passageway 25 depicted.  
The reducing passageway 25 can be fabricated from a  
single piece having, for example, a frusto conical bore  
or, as depicted, with a plurality of individual pieces  
25 such as the first, second, and third pieces 26, 28 and  
30, respectively, depicted. Individual pieces can be  
more easily cleaned. Also, the convergence angle and  
other attributes, e.g., internal surface, can be adjusted  
as needed (e.g., smoothness, anti-stick surface) to  
30 accommodate differences in the extrudate characteristics  
of different food products. In Figure 2, it is seen  
that the passageway 14 has an initial relatively larger  
diameter 34 and a final relatively smaller or exit  
diameter 36 at the exit port 13. Moreover, while the  
35 passageway 14 is depicted as having a circular cross  
sectional area, in other embodiments the passageway 14 can  
be fabricated with a more complex pattern or peripheral

-10-

1 configuration to define or define in part the exterior  
shape or configuration of the finished piece, including  
both regular shapes (e.g., stars, rings, ovoids, geometric  
shapes) as well as irregular shapes (e.g., animals,  
5 objects such as trees, cars, etc.). Furthermore, the  
passageway 14 can be fabricated with an interior surface  
of desired characteristics, e.g., polished or Teflon or  
other non-sticking surface, such as to provide decreased  
friction to facilitate retention of the complex pattern  
10 or to reduce the pattern's deformation. Especially  
desirable is an ovoid cross section for the passageway for  
preparation of an American style football or a rugby ball.

An important feature of the present invention is the  
convergence angle of the reducing passageway 25. It has  
15 been found important to maintain an average convergence or  
confinement angle of  $5^{\circ}$  to  $45^{\circ}$ , preferably  $5^{\circ}$  to  $20^{\circ}$ , and  
most preferably  $10^{\circ}$  to  $15^{\circ}$  in order to maintain the  
pattern while the cross sectional area is reduced. By  
"average convergence" is meant the angle formed from the  
20 diameter of the die insert 20 to the diameter 36 of exit  
port 13 over the length of the reducing passageway 25. As  
depicted, with passageway pieces 26, 28, and 30, some  
pieces, e.g., 26 and 30, have a sharper convergence angle  
while piece 28 has a shallower angle. Internal  
25 obstructions (e.g., shoulders) are to be avoided so as to  
provide a continuous passageway to minimize disrupting the  
complex pattern formed in the dough. Figure 2 shows that  
the exit orifice diameter 36 is about 3 mm. Since the  
passageway 14 can have a complex cross sectional shape as  
30 described above, the extent of reduction of the pattern is  
more aptly characterized in terms of cross sectional area  
reduction rather than more simply a reduction in diameter.  
Thus the degree of reduction of cross sectional area in  
the illustrated embodiment is about 100:1. Of course, for  
35 other embodiments (e.g., for larger snack pieces), the  
extent of cross section reduction can be as little as 25:1.

-11-

- 1 The exit orifice diameter 36 for a snack product can be correspondingly larger, e.g., 5 to 15 mm.

Surprisingly, such a shallow convergence angle allows for a reduction in cross sectional areas of at least 50:1  
5 and even about 100:1 while maintaining a fine level of detail in the complex pattern. Thus, a complex shape can be imparted to a larger dough face or cross section and then reduced to the much smaller desired finish cross sectional area. This arrangement allows for the  
10 fabrication of a relatively large die insert to impart the complex pattern. Fabricating a small die insert to impart the desired degree of detail for the final exit diameter while possible on a development scale extruder is not commercially practical due in part to plugging or fouling  
15 of the die insert 20. The provision of a reducing passageway 25 having the requisite convergence angle allows for the provision of three dimensional shapes to be produced with a fine level of color detail. Moreover, the finished pieces are characterized by a color through  
20 the entire piece as compared to only topical coloration.

Also, it is seen that the mixing is not immediately proximate the discharge port 13 but distanced therefrom. This allows for the dough to modestly "set" so as to assist in maintaining the complex shape.

25 Reference is now made to Figure 3 which shows an enlarged cross section of the pattern forming die insert 20. As can be seen, this particular die insert can be used to fabricate a bicolored food piece 40 as seen in Figure 7 having a swirl or spiral pattern. However, other  
30 pattern forming die inserts can be substituted therefor which, for example, can impart the line pattern for products reminiscent of soccer balls, basketballs, baseballs, and other sports objects.

The die insert 20 includes a means for imparting at  
35 least one, and more desirably a plurality of, dough interstitial gaps such as between a plurality of dough dividing passageways such as passageways 44, 45, and 46

-12-

1 respectively formed by die dividing members 47. The die  
insert 20 can further include a means for injecting a  
food color or second colored dough into the interstitial  
dough gaps such as a plurality or array of evenly spaced  
5 food color injection ports 48 formed in die dividing  
members 47 and fed by a fluid supplying passageway 50  
therethrough. The extrudable food product itself may be  
colored. The color supply 18 may supply a different  
color or the same color having a darker or lighter hue.  
10 Specifically, the food color passageways 50 are supplied  
with the food liquid from one or more food color supply  
ports such as ports 52, 54, and 56, respectively in the  
die dividing members 47. Of course, when the second or  
colored material is a food product such as a second dough  
15 or fruit paste, the passageways and injection ports can be  
enlarged to reduce friction and the potential for blockage.

Referring now briefly to Figure 4, it can be seen that  
the die insert 20 can further include a color fluid supply  
reservoir 58 supplied by the color supply 18 and which is  
20 in fluid communication with or supplies food color supply  
ports 52, 54, and 56. The die insert 20 can further  
include a means for sealing the color fluid supply  
reservoir 58 against premature admixture with dough such  
as "O" rings 60 and 62 depicted.

25 Reference is now briefly made to Figure 5 which shows  
the upstream face 64 of the die insert 22. Figure 5 shows  
that the upstream face 64 for this particular die insert  
contains no color supply discharge ports and that the  
discharge of color is preferably in a downstream  
30 direction.

Reference is now made briefly to Figure 6 wherein the  
relationship between the supply inlet ports 52, 54, and  
56, supply passageways 50 and color discharge ports 48  
can be most simply seen. It can then be appreciated that  
35 the color will tend to fill the interstitial gaps in the  
flowing dough between passageways 44, 45, and 46 formed  
by and behind die dividing members 47 to create a line in

-13-

1 the shape of die dividing members 47 in the extruded dough  
flow. Referring now to Figures 3 and 4, notches 57 are  
provided in die dividing members 47 extending axially from  
the downstream face towards but spaced from upstream face  
5 64 and specifically upstream from the discharge ends of  
ports 48. The axial length of notches 47 is sufficient  
such that the dough extruded through passageways 44, 45,  
and 46 tends to flow into and fill the portions of the  
interstitial gaps in notches 47 upstream of where the  
10 color is discharged from ports 48. The portions of the  
interstitial gaps axially in line with notches 47 are  
then filled with dough upstream from where the color is  
discharged to prevent color added by ports 48 from flowing  
into those portions.

15 In the preferred form shown in Figures 3 and 4,  
notches 47 are shown formed in die dividing members 47  
intermediate ports 48 and the interior surface wall and in  
the preferred form adjacent to the interior surface wall  
of die insert 20. If die dividing members 47 extend to  
20 and engage the interior surface wall of die insert 20,  
color will tend to travel in the interstitial gaps all the  
way to the interior surface wall of die insert 20 and will  
tend to fill the void between the dough passing through  
passageways 44, 45, and 46 and the interior surface wall  
25 of die insert 20. This leads to a disproportionate amount  
of color being on the outside of the extruded dough.  
Thus, notches 47 generally prevent color from traveling  
all the way to the interior surface wall of die insert 20  
to practically eliminate or reduce the color on the  
30 outside of the extruded dough.

It can also be appreciated that notches 57 can also  
be provided in die dividing members 47 spaced from the  
interior surface wall of die insert 20. One reason for  
such an arrangement would be where multiple colors are  
35 desired in the extruded dough. This can be accomplished  
by supplying a first color to certain of the ports 48  
with the other ports 48 being supplied with a different

-14-

1 color(s) or hue(s). Notches 47 can then be provided in  
die dividing members 47 separating those certain ports 48  
from the other ports 48 to generally prevent intermixing  
of the additives in the extruded dough.

5 Reference now is next briefly made to Figures 7 and 8  
which show that the food piece 40 can have a cupped shape  
and that the coloration can extend throughout the body of  
the piece. The piece 40 depicted is a puffed R-T-E cereal  
piece prepared by direct expansion from the extruder  
10 having a finished diameter of about 70 mm.

In the present invention, the complexly patterned  
dough of reduced cross sectional diameter is extruded  
through the reduced diameter exit orifice 36 (e.g., about  
3 mm). Thereafter, the extrudate is face cut in a  
15 conventional manner to form individual pieces such as  
with one or more rotating knives. Depending upon the  
conditions of the extrudate, an unpuffed pellet piece can  
be formed for subsequent puffing, or, alternatively, and  
preferably herein, a directly expanded finished puffed  
20 piece is formed. The finished food piece whether  
subsequently puffed or puffed by direct expansion upon  
exiting the exit orifice 13 is essentially characterized  
by exhibiting a high resolution or fine degree of color  
detail. The detail can include surface line coloration  
25 of as thin as about 0.5 mm in the puffed product. In  
certain embodiments, the interior is also bicolored or  
multicolored as well as having topical or surface  
coloration.

The extrudable food can comprise a wide variety of  
30 conventional food types and in particular can include a  
fruit paste, potato dough (e.g., for a fabricated chip) or  
a cooked cereal dough. The cooked cereal dough can be for  
either R-T-E cereals (whether puffed or unpuffed), snack  
products, baked goods, or pastas. Especially desirable  
35 are cooked cereal doughs for puffed R-T-E cereals.  
Puffed food products such as snacks can be prepared by  
hot air puffing, deep fat frying, gun puffing or microwave

-15-

- 1 (especially high intensity, e.g., >100 V/cm field strength). Product puffed without deep fat frying can have oil added to the composition or have a topical oil application. R-T-E cereals can have a sugar coating.
- 5 Puffed food pieces of the product base (i.e., prior to or without oil or sugar) can have a density of about 0.1 to 0.5g/cc. The colored portion forms a line or a plane through the body of the food piece. "Highly complex" food products are characterized as having a plurality of
- 10 colored features at least two of which (e.g., two planes or a line and a plane) intersect within the body of the food piece.

While in the present invention, the particular die insert 20 depicted is designed to admix a liquid food

15 color into a cooked cereal dough so as to provide line coloration of extremely fine detail, the die insert 20 can be modified (e.g., such as by enlargement of ports 52, 54, and 56, fluid passageways 50, and discharge ports 48) to admix two or more cooked doughs or other flowable

20 colored food materials, especially liquefied fats (e.g., chocolate, cheese), or fruit paste.

Also, while the particular die insert 20 depicted is designed to provide the swirled finished product depicted, other die inserts can be interchanged to provide the line

25 coloration detail to provide the particular desired end products such as the various sports balls (e.g., soccer, baseball, basketball, American football) referenced above.

It will be appreciated that for those embodiments that are extruded without direct expansion or puffing upon

30 extrusion that lines having a detail of about 0.1 mm in width can be obtained. Upon subsequent expansion (e.g., deep fat frying, gun puffing, fluidized bed puffing, radiant heat puffing or other puffing methods), puffed pieces will of course expand causing an increase in the

35 width of the line. These enlarged lines (i.e., 0.5 mm), however, are nonetheless thinner than lines obtainable by

-16-

- 1 any other known method. If desired, thicker lines (e.g.,  
about 3 mm) can also be formed.

Other dough flow adjustment devices can be used with  
or in substitution for the preferred flow adjuster plug 16  
5 herein if 1) positioned upstream of the die insert 20, and  
2) do not increase the likelihood of downstream plugging.  
For example, and referring to Figures 10 and 11, an  
alternate embodiment of a dough manifold 100 is shown  
according to preferred teachings of the present invention.  
10 In particular, manifold 100 includes body portions 102,  
104, 106 and 108 which are secured together into a unitary  
assembly. In particular, body portion 102 includes a  
circular disc 110 which abuts with the mounting flange 112  
of the outlet of food cooker extruder 12. Disc 110 can be  
15 secured to extruder 12 by any conventional means and in  
the preferred form includes an annular lip 114 formed on  
its outer periphery at the inner axial end which abuts  
with flange 112, with lip 114 being of a size and shape  
generally corresponding to flange 112.

- 20 Bores or conduit portions 118 intersect at the inner  
axial end of disc 110 at the center line of extruder 12  
and disc 110 and extend therefrom at equal acute angles  
on opposite sides of the center line of extruder 12 and  
disc 110 in the order of 62° in the most preferred form,  
25 with the center lines of bores 118 and the center line of  
extruder 12 and disc 110 being arranged in a horizontal  
plane in the most preferred form.

Body portion 102 further includes first and second  
pipes or conduit portions 116 which extend linearly from  
30 bores 118 formed in disc 110 past the outer axial end of  
disc 110 to equal distances from disc 110.

Body portion 102 further includes first and second  
conduit portions 120 located on opposite sides, parallel  
to, and at equal distances from the center line of  
35 extruder 12 and disc 110, with the center lines of conduit  
portions 120, extruder 12 and disc 110 being arranged in  
a horizontal plane in the most preferred form. Conduit

-17-

1 portions 120 have cross sections of an equal size and  
shape to pipes 116. The outer axial ends of first and  
second pipes 116 opposite to disc 110 are integrally  
connected to and in fluid communication with the inner  
5 axial ends of first and second conduit portions 120,  
respectively, in the most preferred form by a mitered  
interconnection. The outer axial ends of conduit portions  
120 are equally spaced from disc 110 and extruder 12.

Body portion 102 further includes a flat mounting  
10 plate 122 which is held generally perpendicular to the  
center lines of conduit portions 120, extruder 12 and disc  
110 by a support 124 extending between and integrally  
connected to the outer axial end of disc 110 and the inner  
axial end of plate 122. Conduit portions 120 extend  
15 through suitable bores formed in mounting plate 122 and  
are integrally secured to mounting plate 122. The outer  
axial end of mounting plate 122 is perpendicular to the  
center lines of conduit portions 120, disc 110, and  
extruder 12 and is at the same axial extent from disc  
20 110 and extruder 12 as the outer axial ends of conduit  
portions 120.

Body portion 104 is in the most preferred form of a  
block having an inner axial end which abuts with mounting  
plate 122. Body portion 104 is symmetrical on opposite  
25 sides of the center line of disc 110 and extruder 12  
according to preferred teachings of the present invention.  
In particular, body portion 104 includes first and second  
conical chambers 126 having center lines which are linear  
with the center lines of conduit portions 120. The bases  
30 of chambers 126 are located at the inner axial end of  
body portion 104 and have a diameter equal to the inner  
diameter of conduit portions 120.

First and second passageway portions 128 of equal size  
and diameter extend from each of chambers 126 at equal  
35 acute angles on opposite sides of the center line of  
chamber 126 and conduit portion 120 in the order of 49°  
in the most preferred form, with the center lines of

-18-

1 passageway portions 128, chambers 126, conduit portions  
220, bores 118, pipes 116 and extruder 12 being arranged  
in a horizontal plane in the most preferred form. Body  
portion 104 further includes third and fourth passageway  
5 portions 130 in fluid communication with first and second  
passageways 128, respectively, and located on opposite  
sides, parallel to and at equal distances from the center  
lines of the first and second chambers 126 and conduit  
portions 120, respectively, with the center lines of  
10 passageway portions 128 and 130 being in a horizontal  
plane in the most preferred form. Passageway portions  
128 and 130 have cross sections of an equal size and shape  
and in the most preferred form have diameters which are  
approximately 57% of the diameter of conduit portions 116,  
15 118, and 120.

Body portion 104 further includes first and second  
duct portions 132 having center lines which are  
coextensive with the center lines of the first and second  
chambers 126 and conduit portions 120, respectively, with  
20 duct portions 132 extending from chambers 126 concentric  
to the center line of chambers 126 and opposite to their  
bases. In the most preferred form, duct portions 132  
have a cross-sectional shape corresponding to passageway  
portions 128 and 130 which is circular in the most  
25 preferred form but have a size which is smaller than  
passageway portions 128 and 130 and in the most preferred  
form have diameters equal to approximately 65% of the  
diameter of passageway portions 128 and 130. In the most  
preferred form, duct portions 132 have a size which do  
30 not intersect with passageway portions 128 at chamber 126,  
with duct portions 132 having a diameter equal to the  
diameter of chambers 126 equal to the outer axial extent  
of passageway portions 128 at the surfaces of chambers  
126 in the most preferred form.

35 Body portion 106 is in the most preferred form of a  
block having an inner axial end which abuts with the  
outer axial end of body portion 104. Body portion 106 is

-19-

1 symmetrical on opposite sides of the center line of disc  
110 and extruder 12 according to the teachings of the  
present invention. In particular, first and second ports  
134 of equal size and diameter extend from the first  
5 passageway portions 130 extending from first and second  
chambers 126 at equal acute angles on opposite sides of  
the center line of first passageway portion 130 in the  
order of  $43^\circ$  in the most preferred form, with the center  
lines of ports 134 and passageway portions 130 being  
10 arranged in a horizontal plane in the most preferred  
form. Further, third and fourth ports 136 of equal size  
and diameter extend from the second passageway portion  
130 extending from first and second chambers 126 at equal  
acute angles on opposite sides of the center line of  
15 second passageway portion 130 in the order of  $43^\circ$  in the  
most preferred form, with the center lines of ports 136  
and passageway portions 130 being arranged in a horizontal  
plane in the most preferred form. Ports 134 and 136 have  
equal lengths. Body portion 106 further includes first  
20 and second duct portions 138 having center lines which  
are coextensive with the center lines of first and second  
duct portions 132 and chambers 126 of body portion 104  
and of conduit portions 120, respectively. Duct portions  
138 have a cross-sectional size and shape corresponding  
25 to duct portions 132. Ports 134 and 136 have the same  
cross-sectional size and shape which in the preferred  
form also are equal to the cross-sectional size and shape  
of duct portions 132 and 138.

Body portion 106 according to the preferred teachings  
30 of the present invention then includes a plurality of flow  
adjuster plugs 16 of a number corresponding to the total  
number of ports 134 and 136 and duct portions 138 formed  
therein and mounted to the upper surface thereof. In  
particular, plugs 16 are mounted such that smooth portion  
35 86 can be adjustably extended into the corresponding port  
134 or 136 or duct portion 138 to adjust the flow rate  
and pressure of the dough flow therethrough.

-20-

1        Body portion 108 is in the most preferred form of a  
block having an inner axial end which abuts with the outer  
axial end of body portion 106. Body portion 108 is  
symmetrical on opposite axial sides of the center line of  
5       disc 110 and extruder 12 according to the teachings of the  
present invention. In particular, sockets 140 equal in  
number and location to ports 134 and 136 and duct portion  
138 are provided for slideable receipt of the desired  
inserts 142. It can be appreciated that inserts 142 can  
10       be of the type including die inserts 20 and passageway  
pieces 26, 28, and 30 or can be of alternate types and  
forms.

Body portions 102, 104, 106, 108 can then be suitably  
secured together such as by bolts 144 extending through  
15       body portions 108 and 106 and threaded into body portion  
104 and by bolts 146 extending through body portions 108,  
106, and 104 and threaded into mounting plate 122. To  
insure proper alignment and for ease of assembly, dowel  
pins 148, 150, and 152 can be provided between body  
20       portions 108 and 106, body portions 106 and 104, and body  
portion 104 and mounting plate 122, respectively.

In operation of manifold 100 according to the  
teachings of the present invention, dough extruded by  
extruder 12 will flow through flow paths at equal rates  
25       and pressure through conduits 116, 118, and 120 into  
chamber 126 since they provide the same resistance to  
flow due to their equal lengths, cross-sectional sizes  
and shapes, and arrangement much like through passageways  
14. Likewise, dough will flow through passageways 128 and  
30       130 from chambers 126 at equal rates and pressure since  
they provide the same resistance to flow due to their  
equal lengths, cross-sectional size and shape, and  
arrangement. Similarly dough will flow through ports 134  
and 136 from passageways 128 and 130 at equal rates and  
35       pressure since they provide the same resistance to flow  
due to their equal lengths, cross-sectional size and  
shape, and arrangement. However, since ducts 132 and 138

-21-

1 have a smaller cross-sectional size than passageways 128  
and 130, the flow rate of dough through a single duct 132  
and 138 is one-half the flow rate through one of ports 134  
and 136. In particular, due to the much shorter length  
5 that the dough must flow to reach die inserts 142 through  
one duct 132 and 138, the cross-sectional size is reduced  
to a size to provide equal flow resistance therethrough  
as through dough flowing through one of the ports 134 and  
136. Further, according to the preferred teachings of  
10 the present invention, the cross-sectional size of ports  
134 and 136 and ducts 132 and 138 are equal for ease of  
fabrication and to allow the same size adjuster plugs 16  
to be utilized in all of the ports 134 and 136 and duct  
portions 138.

15 It can then be appreciated that the flow rate and  
pressure from extruder 12 to inserts 142 are equal even  
though the flow distances from extruder 12 to inserts 142  
are not equal according to the teachings of the present  
invention. Specifically, the flow rate and pressure to  
20 inserts 142 are generally compensated by providing unequal  
flow areas to effect equalizing flow resistance and are  
fine tuned through the use of adjuster plugs 16 according  
to the teachings of the present invention. Thus,  
utilizing the present invention, it is no longer required  
25 that the inserts 142 be located in a circular pattern  
centered on the center line of extruder 12 to obtain equal  
flow distances in symmetrical arrangements. Particularly,  
other patterns are possible according to the teachings of  
the present invention such as horizontal in a single plane  
30 which avoids problems of individual extrudates interfering  
with each other such as upper extrudates falling on lower  
extrudates in the circular pattern and which allows easier  
placement on horizontally arranged conveyors.

Now that the basic teachings of the present invention  
35 have been explained, many extensions and variations will  
be obvious to one having ordinary skill in the art. For  
example, several inventive aspects of the present invention

-22-

1 have been disclosed and it is believed that the combination  
thereof produces synergistic results. However, such  
inventive aspects can be utilized alone or in other  
combinations according to the teachings of the present  
5 invention. As an example, although notches 47 have been  
disclosed in die insert 20 forming complexly patterned  
extrudates, similar inserts could be provided upstream  
of a static mixer to provide several lines of colorant,  
flavor or other additives rather than typical point type  
10 injections into the cross section of flow. In particular,  
notches 47 prevent the colorant, flavor or other additives  
from coming in contact with the interior surface wall of  
the insert where the static mixer has difficulty mixing  
it thoroughly with the main flow of product. This would  
15 allow the static mixer to be shorter and still provide a  
uniform extrudate and thus reducing the cost, space and  
pressure drop requirements of the static mixer.

Thus since the invention disclosed herein may be  
embodied in other specific forms without departing from  
20 the spirit or general characteristics thereof, some of  
which forms have been indicated, the embodiments  
described herein are to be considered in all respects  
illustrative and not restrictive. The scope of the  
invention is to be indicated by the appended claims,  
25 rather than by the foregoing description, and all changes  
which come within the meaning and range of equivalency of  
the claims are intended to be embraced therein.

-23-

CLAIMS

1. An apparatus for making a complexly patterned flowable extrudate, comprising, in combination:
  - means for providing a first extrudable food material (12);
  - means for supplying a second flowable colored food material (18);
  - means for forming the first extrudable food material and the second flowable colored food material into a complexly patterned food mass having an initial cross sectional area (20);
  - reducing passageway means for reducing the initial cross sectional area to a reduced cross sectional area of at least 25:1 operatively connected to the pattern forming means having an average convergence angle ranging from about 5° to 45° (25) and having a larger inlet end and a smaller outlet end; and
  - an extrudate exit port having a diameter of about the reduced cross sectional area (13) proximate the outlet end.
2. The apparatus of claim 1
  - wherein the means for providing at least one extrudable food product includes at least one extrudate passageway (14) each having an initial cross sectional area,
  - wherein the means for forming a complex patterned food mass includes an enlarged die insert (20) having an enlarged cross section relative to the cross section of the exit port within an enlarged portion of the extrudate passageway having a die insert diameter (21) and cross sectional area and wherein the ratio of the die insert cross section area to the reduced cross sectional area ranges from 25 to 100:1.
3. The apparatus of claim 2 wherein the die insert (20) includes at least one food product dividing member (47) having a passageway therethrough (50) in fluid communication with the second colored food material supply means (18) and a plurality of second colored food material supply discharge

-24-

holes (48).

4. The apparatus of claim 3 wherein the second colored food material supply discharge holes (48) are evenly spaced and are in the downstream face of the die insert (20).

5. The apparatus of claim 4 wherein the reducing passageway (25) includes a plurality of pieces.

6. The apparatus of claim 5 wherein each passageway piece has a cross section equal to the upstream cross section of the next downstream piece so as to form a continuously smooth passageway.

7. The apparatus of claim 6 wherein at least a portion of the reducing passageway (25) has a circular cross section.

8. The apparatus of claim 6 wherein at least a portion of the reducing passageway (25) has an irregularly shaped periphery.

9. The apparatus of claim 8 wherein the passageway (14) includes a passageway expanding flared portion (21) immediately upstream of the die insert (20).

10. The apparatus of claim 9 wherein the means for providing a first extendable food material additionally comprises a means for externally adjusting the dough flow rate upstream of the die insert.

11. The apparatus of claim 10 wherein the means for externally adjusting the dough flow rate includes

a rounded smooth refractably adjustable plug projecting into the passageway;

means for adjustably retractably extending the plug into the passageway including stop means exterior to the passageway for terminating the extension of the plug into the passageway;

means for mounting the flow rate apparatus to the food extruder;

wherein the length of the plug extending into the passageway when stopped is less than 90% of the width of the passageway; and

means for sealing the plug against food leakage.

-25-

12. The apparatus of claim 6 wherein at least a portion of the reducing passageway has an oval cross section.

13. The apparatus of claim 3 wherein the food product dividing member imparts at least one interstitial gap, with the dividing member including an upstream face and a downstream face; wherein the second colored food material supply discharge holes (48) supply the second colored food material at the downstream face and into the interstitial gap, with the second colored food material traveling in the interstitial gap; and wherein the apparatus further comprises, in combination: a notch formed in the dividing member extending from the downstream face towards but spaced from the upstream face and having an axial length sufficient for the first extrudable food material to flow into and fill the interstitial gap within the notch.

14. The apparatus of claim 13 wherein the die insert further includes an interior surface wall, with the food product dividing member extending to and engaging the interior surface wall, with the notch located in the food product dividing member intermediate the second food material supply discharge holes and the interior surface wall.

15. A method for preparing a food product having at least two colors exhibiting improved detail resolution; comprising the steps of:

- A. providing a first plastic extrudable food mass having a first color;
- B. providing at least a second flowable food material having a second color differing from the first color in color or hue;
- C. mixing the food mass and the second food material to form a complexly patterned food mass having an initial cross sectional area;
- D. reducing the cross sectional area of the complexly patterned food mass by a factor of at least 4:1 through a reducing passageway with an average convergence angle of 5° to 45° while maintaining the

-26-

cross sectional pattern to form a reduced cross sectional patterned extrudate; and

E. extruding the reduced cross sectional extrudate through a die port.

16. The method of claim 15 wherein the initial cross section of the first food mass is about 1200 to 3000 mm<sup>2</sup> and wherein the reduced cross sectional area is about 10 to 300 mm<sup>2</sup>.

17. The method of claim 16 wherein the food and color are mixed in a passageway of a cooker extruder with a die dividing insert therein and wherein the reducing passageway is continuous.

18. The method of claim 17 wherein the first food mass comprises a cooked cereal dough.

19. The method of claim 18 wherein the cross sectional area is reduced in a converging frusto conically shaped passageway.

20. The method of claim 19 wherein the extrudate is directly expanded upon and cut to form individual pieces of puffed cereal dough.

21. The method of claim 19 wherein the extrudate is extruded to form an unexpanded complexly patterned dough of reduced cross sectional area; and wherein the method additionally comprises the steps of:

F. sectioning the extruded complexly patterned dough to form individual half product or pellet pieces having a complex pattern; and

G. puffing the pieces to form puffed food pieces.

22. The method of claim 21 wherein the puffed food pieces have a spherical shape.

23. The method of any claim 15-22 wherein the mixing step comprises the steps of: dividing the food mass to impart at least one interstitial gap in the food mass; partially filling the interstitial gap with the food mass; and injecting the second flowable food material at a location downstream of where the interstitial gap is partially filled in remaining portions of the interstitial

-27-

gap.

24. The method of claim 23 wherein the step of dividing the food mass comprises the step of providing a die dividing member including an upstream face and a downstream face; wherein the partially filling step comprises the step of notching the die dividing member from the downstream face towards but spaced from the upstream face and having an axial length sufficient for the food mass to flow into and fill the interstitial gap within the notch; and wherein the injecting step comprises the step of injecting the second flowable food material at the downstream face and into the interstitial gap, with the second flowable food material traveling in the interstitial gap.

25. A puffed food piece having a body of one color and at least two intersecting colored lines or planes of a second color or hue extending through the body.

26. The food product of claim 25 wherein the colored lines have a thickness of 1 mm>.

27. The food product of claim 26 wherein the body is fabricated from a puffed cooked cereal or potato dough.

28. The food product of claim 26 having a spherical shape with a plurality of lines forming a shape of a soccer ball, a baseball, and American style football.

29. The food product of claim 26 having a diameter of about 15 to 30 mm.

30. Flow rate adjustment apparatus for adjustment of plastic extrudable food flow through a port, with the port having circular cross sections and a center line, comprising, in combination: a plug having circular cross sections of a diameter less than the cross sections of the port and a center line; and means for extending the plug into the port with the center line of the plug being at a non-parallel angle to the center line of the port.

31. The flow rate adjustment apparatus of claim 30 wherein the center line of the plug is perpendicular to the center line of the port; and wherein the plug has an axial end located inside of the port, with the axial end of the

-28-

plug having a diameter which is considerably larger than the diameter of the port such that the axial end of the plug can not mate with the port allowing flow of dough between the axial end of the plug and the port at all positions of the plug.

32. The flow rate adjustment apparatus of claim 31 wherein the extending means comprises, in combination: a bolt, with the plug formed on the bolt, with the bolt being threadable to extend or retract the plug into the port.

33. The flow rate adjustment apparatus of claim 32 wherein the extending means further comprises, in combination: a lock nut threaded on the bolt and which can be tightened to secure the bolt against movement such as caused by vibration.

34. A flow rate adjustment apparatus for adjustment of plastic extrudable food flow in a passageway of a food extruder, comprising, in combination:

a rounded smooth refractably adjustable plug projecting into the passageway;

means for adjustably retractably extending the plug into the passageway including stop means exterior to the passageway for terminating the extension of the plug into the passageway;

means for mounting the flow rate apparatus to the food extruder;

wherein the length of the plug extending into the passageway when stopped is less than 90% of the width of the passageway; and

means for sealing the plug against food leakage.

35. The apparatus of claim 34 wherein the means for adjustably retractably extending the plug includes

a bore in the extruder intersecting with the passageway at a downstream angle of  $90^\circ$  having an outward threaded portion and an inward smooth portion, and

wherein the plug has an outward portion having threads and an inward smooth portion.

36. Manifold for making multiple extrudates formed from

-29-

a food dough exiting from a source and having uniformity of flow, comprising, in combination: a plurality of exit orifices located at differing spacings from the source; and with each of the exit orifices including a flow path for the food dough from the source to the exit orifice, with the flow paths of at least two pair of the exit orifices being formed by at least first and second passageways and first, second, third, and fourth ports, with the first and second passageways extending at a passageway angle relative to each other and having equal cross-sectional sizes and shapes, with the first and second ports extending from the first passageway and having generally equal cross-sectional sizes and shapes and the third and fourth ports extending from the second passageway and having generally equal cross-sectional sizes and shapes generally equal to the cross-sectional sizes and shapes of the first and second ports and less than the cross-sectional sizes of the first and second passageways, with the first and second passageways having generally equal lengths, with the first, second, third, and fourth ports having generally equal lengths.

37. The manifold of claim 36 wherein the flow paths each include means for adjusting the rate and pressure of the flow of the dough.

38. The manifold of claim 37 wherein the adjusting means each comprise a plug extendable into the flow path.

39. The manifold of claim 38 wherein the cross sections of the port and the plug are circular and each include a center line, with the diameter of the plug being less than the diameter of the port, with the center line of the plug being at a non-parallel angle to the center line of the port.

40. The manifold of claim 39 wherein the center line of the plug is perpendicular to the center line of the port; and wherein the plug has an axial end located inside of the port, with the axial end of the plug having a diameter which is considerably larger than the diameter of the port such that the axial end of the plug can not mate with the port allowing flow of dough between the axial end of the plug and

-30-

the port at all positions of the plug.

41. The manifold of claim 38 wherein the adjusting means each further comprises, in combination: a bolt, with the plug formed on the bolt, with the bolt being threadable to extend or retract the plug into the port.

42. The manifold of claim 41 wherein the adjusting means each further comprises, in combination: a lock nut threaded on the bolt and which can be tightened to secure the bolt against movement such as caused by vibration.

43. The manifold of claim 39 wherein the flow path of at least one of the exit orifices is formed by a duct having a constant size from the interconnection of the first and second passageways to the die insert, with the cross-sectional size of the duct being less than the cross-sectional size of the first and second passageways.

44. The manifold of claim 43 wherein the duct has a cross-sectional size and shape generally equal to the cross-sectional size and shape of the first, second, third, and fourth ports.

45. The manifold of claim 44 wherein the flow paths further comprise a conical chamber having a base and a center line, with the first and second passageways extending from the conical chamber at equal angles on opposite sides of the center line of the conical chamber, with the duct extending from the conical chamber concentric to the center line and opposite to the base.

46. The manifold of claim 45 wherein the first and second ports extend at a port angle on opposite sides of the first passageway and the third and fourth ports extend at the port angle on opposite sides of the second passageway.

47. The manifold of claim 43 wherein the plurality of exit orifices are located in a single, horizontal plane.

48. The manifold of claim 36 or 37 wherein the flow paths further comprise, in combination: first and second conduits extending at an angle relative to each other and having generally equal cross-sectional sizes and shapes and greater than the cross-sectional sizes of the first and

-31-

second passageways, with the first and second conduits having generally equal lengths, with the first and second passageways extending from the first conduit; third and fourth passageways extending from the second conduit; and fifth, sixth, seventh, and eighth ports, with the fifth and sixth ports extending from the third passageway and the seventh and eighth ports extending from the fourth passageway.

49. The manifold of claim 48 wherein the source comprises an outlet including an annular mounting flange; and wherein the manifold further comprises a disc for abutting with and securement to the annular mounting flange, with the first and second conduits extending from bores formed in the disc, with the bores being in communication with the source.

50. The manifold of claim 49 further comprising, in combination: a mounting plate supported by the disc, with the conduits extending into and through the mounting plate; and a manifold block secured to the mounting plate, with the passageways and ports formed in the manifold block.

51. The manifold of claim 36 wherein the flow path of at least one of the exit orifices is formed by a duct having a constant size from the interconnection of the first and second passageways to the exit orifice, with the cross-sectional size of the duct being less than the cross-sectional size of the first and second passageways.

52. The manifold of claim 51 wherein the duct has a cross-sectional size and shape generally equal to the cross-sectional size and shape of the first, second, third, and fourth ports.

53. Method for adding at least a first additive to flowing dough comprising the steps of: dividing the flowing dough to impart at least one dough interstitial gap in the flowing dough; partially filling the interstitial gap with dough from the flowing dough; and injecting the additive at a location downstream of where the interstitial gap is partially filled in remaining portions of the interstitial

-32-

gap.

54. The method of claim 53 wherein the step of dividing the flowing dough comprises the step of providing a die dividing member including an upstream face and a downstream face; wherein the partially filling step comprises the step of notching the die dividing member from the downstream face towards but spaced from the upstream face and having an axial length sufficient for the dough to flow into and fill the interstitial gap within the notch; and wherein the injecting step comprises the step of injecting the additive at the downstream face and into the interstitial gap, with the additive traveling in the interstitial gap.

55. The method of claim 54 wherein the providing step comprises the step of providing the die dividing member extending to and engaging an interior surface wall of an insert, with the flowing dough flowing through the interior surface; and wherein the notching step comprises the step of notching the die dividing member intermediate the location at which the additive is injected and the interior surface wall.

56. The method of any one of claims 53-55 wherein the dividing step comprises the step of dividing the flowing dough into at least first and second passageways.

57. Apparatus for adding at least a first additive to flowing dough comprising, in combination: a die dividing member in the flowing dough to impart at least one dough interstitial gap, with the die dividing member including an upstream face and a downstream face; means for injecting the additive at the downstream face and into the interstitial gap, with the additive traveling in the interstitial gap; and a notch formed in the die dividing member extending from the downstream face towards but spaced from the upstream face and having an axial length sufficient for the dough to flow into and fill the interstitial gap within the notch.

58. The apparatus of claim 57 wherein the dough flows through an insert having an interior surface wall, with the die dividing member extending to and engaging the interior

-33-

surface wall, with the notch located in the die dividing member intermediate the injecting means and the interior surface wall.

59. The apparatus of claim 58 wherein the notch is formed adjacent to the interior surface wall.

60. The apparatus of any one of claims 57-59 wherein the die dividing member divides the flowing dough into at least first and second passageways.

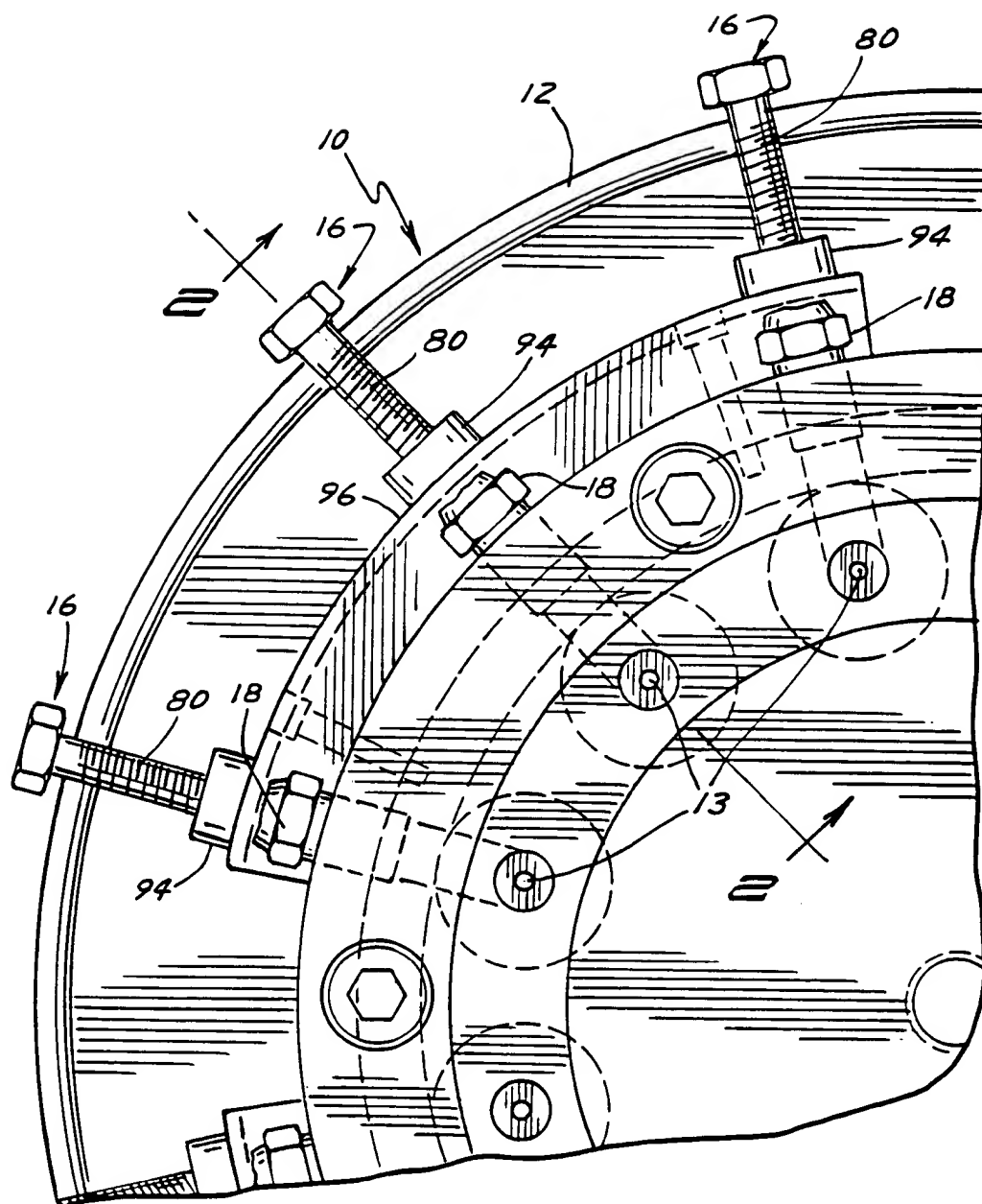
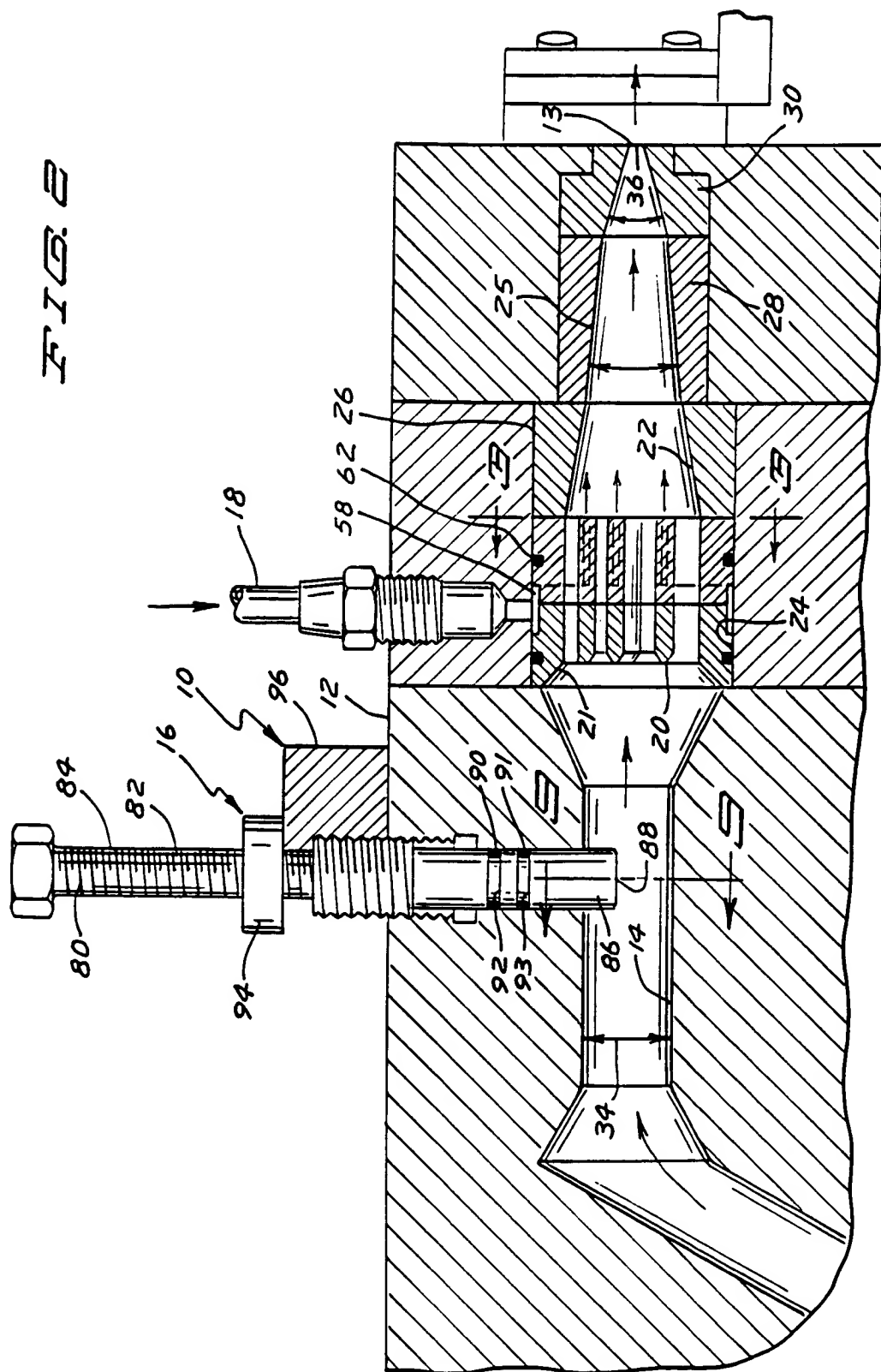
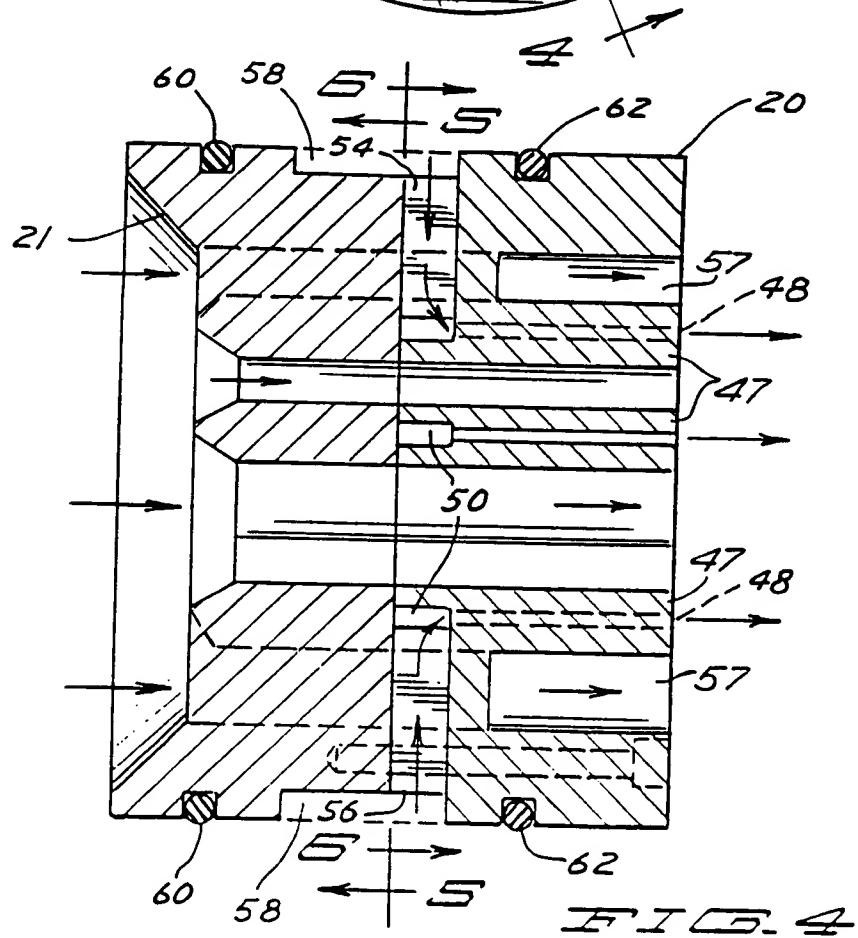
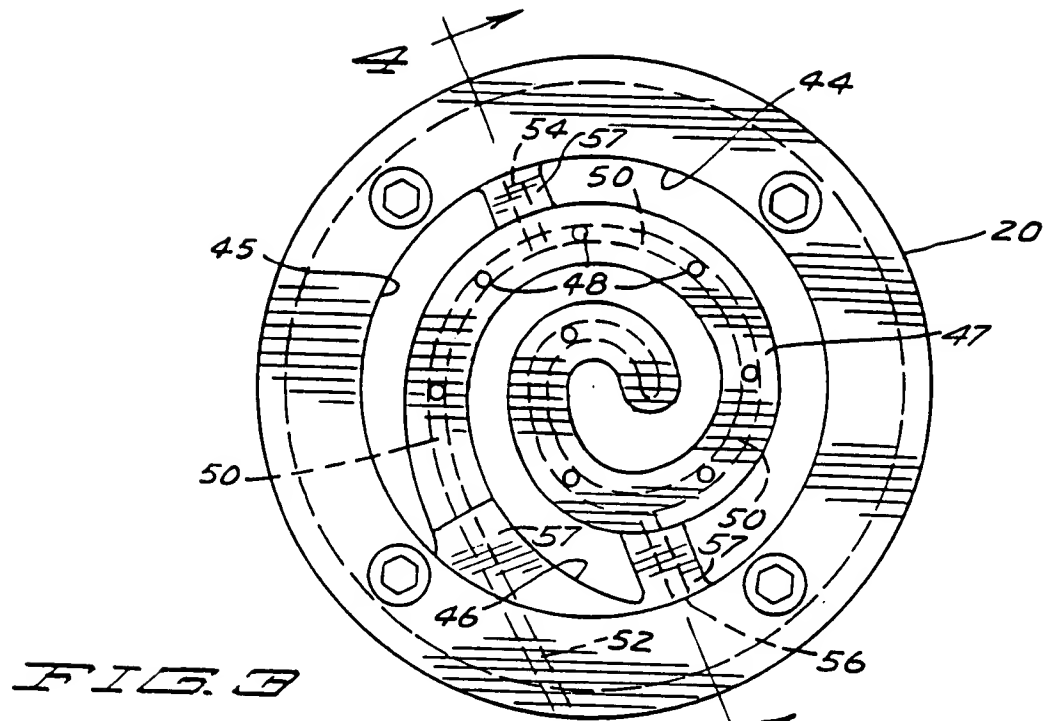
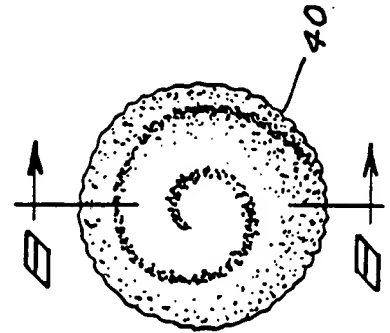
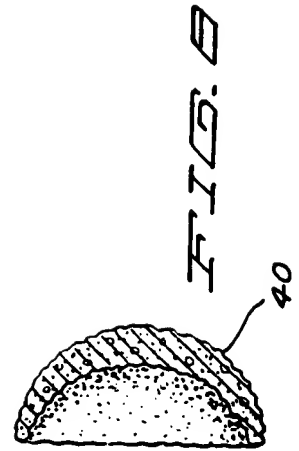
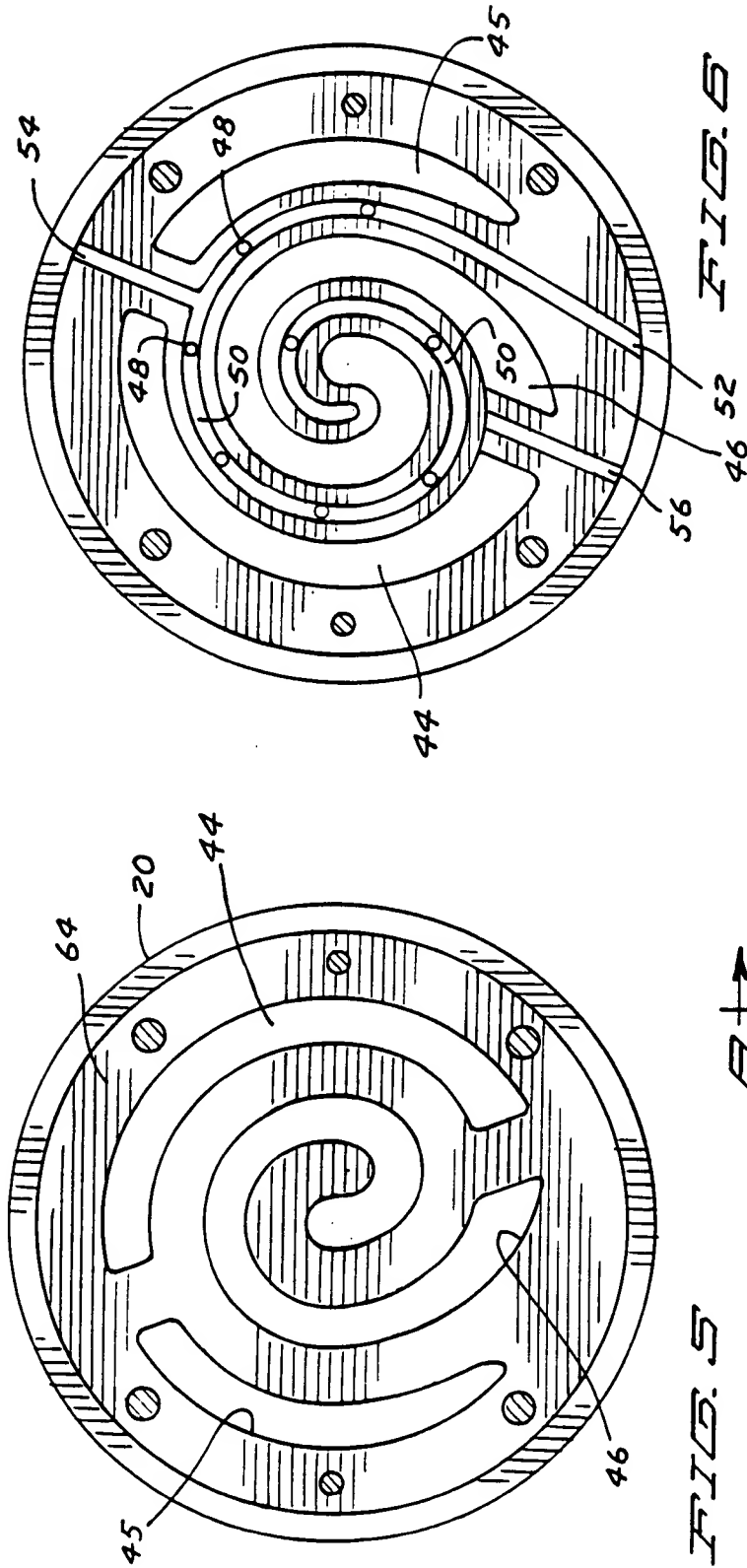
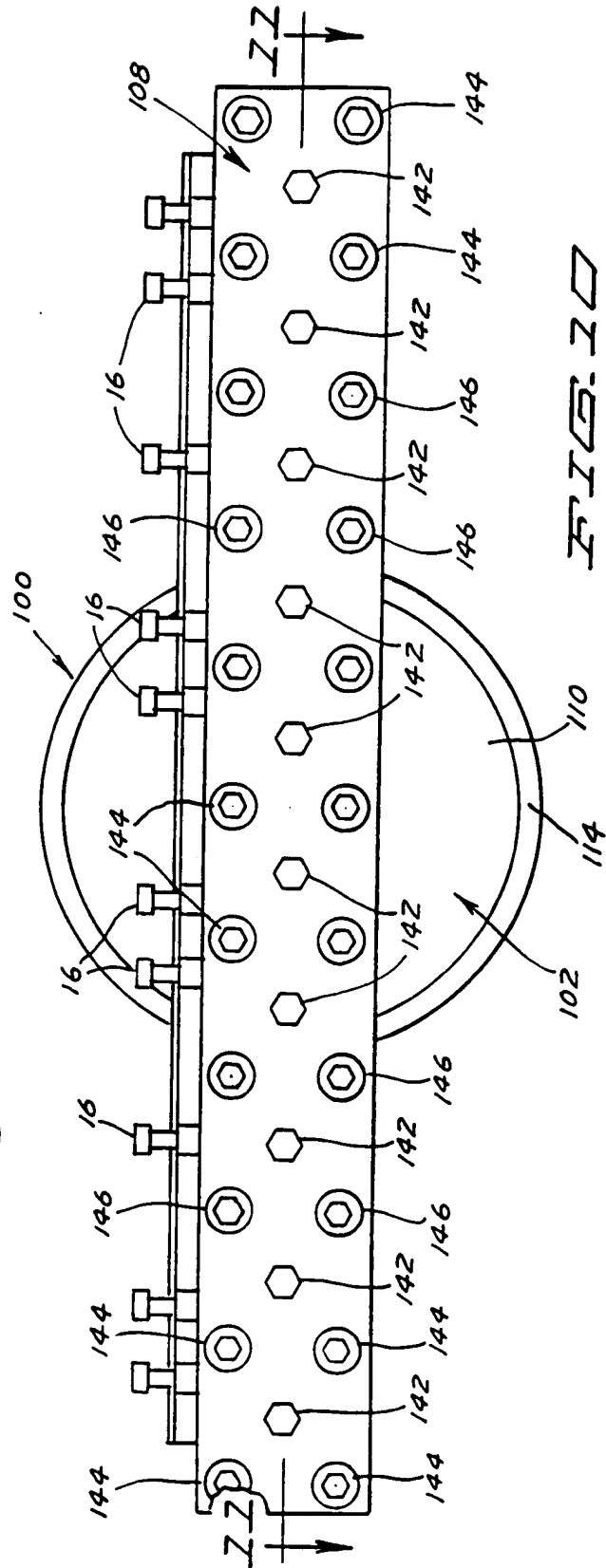
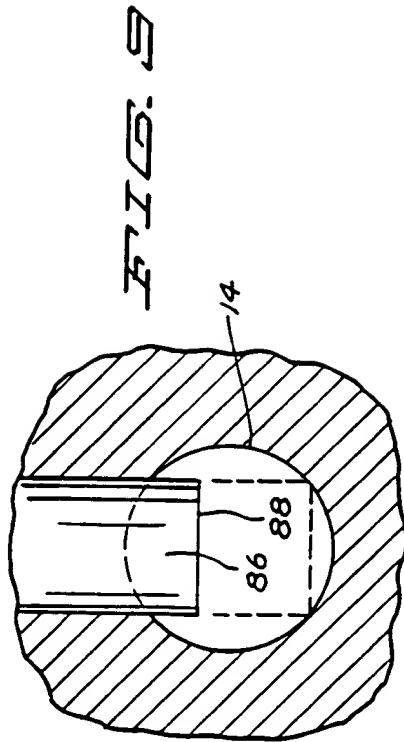
*FIG. 1*

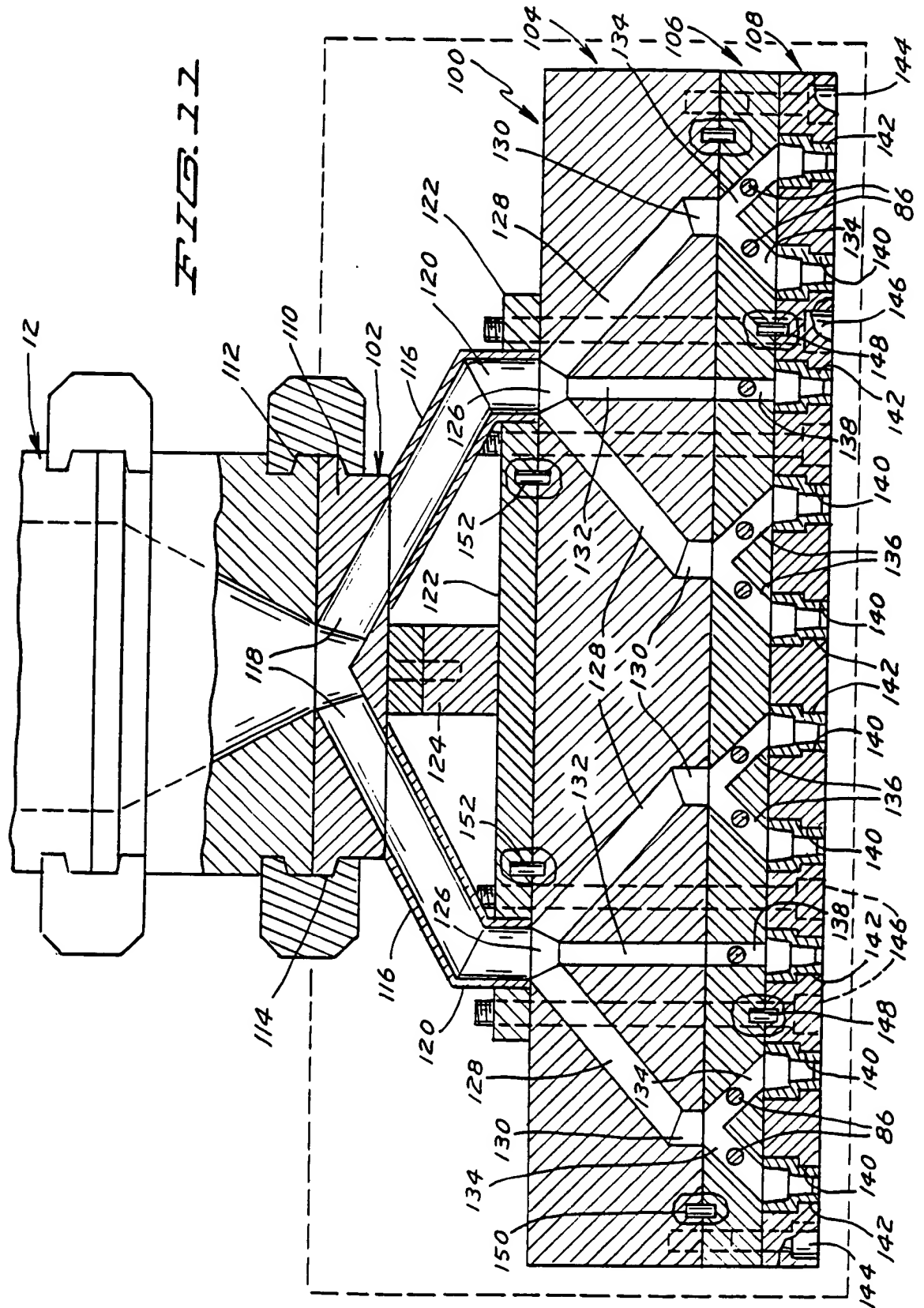
FIG. 2











## INTERNATIONAL SEARCH REPORT

Intern. Application No  
PCT/US 95/05553A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 A21C11/16 A21C11/18 A21C11/20

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,3 314 381 (E.W. FRIES ET AL) 18 April 1967 -----	

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

## \* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*&\* document member of the same patent family

Date of the actual completion of the international search

29 August 1995

Date of mailing of the international search report

12.09.95

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+ 31-70) 340-3016

Authorized officer

Franks, N

## PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION CONCERNING  
DOCUMENT TRANSMITTED

To:

United States Patent and Trademark  
Office  
(Box PCT)  
Washington D.C. 20231  
United States of America

in its capacity as elected Office

Date of mailing (day/month/year)

28 July 1995 (28.07.95)

International application No.

PCT/US94/04314

International filing date (day/month/year)

19 April 1994 (19.04.94)

Applicant

KAUFFMAN, Stuart, A. et al

The International Bureau transmits herewith the following documents and number thereof:

\_\_\_\_\_ copy of the international preliminary examination report (Article 36(3)(a))

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

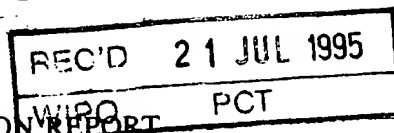
K. Andreasson

Telephone No.: (41-22) 730.91.11

# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)



Applicant's or agent's file reference 2860/18	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US94/04314	International filing date (day/month/year) 19 APRIL 1994	Priority date (day/month/year) 19 APRIL 1993
International Patent Classification (IPC) or national classification and IPC IPC(6): C12Q 1/68; C12P 19/34, 21/00; C12N 15/63 and US Cl.: 435/6, 188.5, 252.4		
Applicant KAUFFMAN, Stuart A.		

- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 3 sheets.  
☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
These annexes consist of a total of — sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand  21 NOVEMBER 1994	Date of completion of this report  29 JUNE 1995
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer SCOTT HOUTTEMAN
Facsimile No. (703) 305-3230	Telephone No. (703) 308-0196

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US94/04314

**I. Basis of the report**

1. This report has been drawn on the basis of *(Substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments)*:

- ☒ the international application as originally filed.
- ☒ the description, pages 1-68 , as originally filed.  
pages NONE , filed with the demand.  
pages NONE , filed with the letter of \_\_\_\_\_.  
pages \_\_\_\_\_ , filed with the letter of \_\_\_\_\_.
- ☒ the claims, Nos. 1-50 , as originally filed.  
Nos. NONE , as amended under Article 19.  
Nos. NONE , filed with the demand.  
Nos. NONE , filed with the letter of \_\_\_\_\_.  
Nos. \_\_\_\_\_ , filed with the letter of \_\_\_\_\_.
- ☒ the drawings, sheets/fig NONE , as originally filed.  
sheets/fig NONE , filed with the demand.  
sheets/fig NONE , filed with the letter of \_\_\_\_\_.  
sheets/fig \_\_\_\_\_ , filed with the letter of \_\_\_\_\_.

2. The amendments have resulted in the cancellation of:

- ☒ the description, pages NONE .
- ☒ the claims, Nos. NONE .
- ☒ the drawings, sheets/fig NONE .

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the ~~Supplemental Box~~ Additional observations below (Rule 70.2(c)).

4. Additional observations, if necessary:

NONE

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US94/04314

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. STATEMENT**

Novelty (N)	Claims <u>1-50</u>	YES
	Claims <u>NONE</u>	NO
Inventive Step (IS)	Claims <u>1-50</u>	YES
	Claims <u>NONE</u>	NO
Industrial Applicability (IA)	Claims <u>NONE</u>	YES
	Claims <u>1-50</u>	NO

**2. CITATIONS AND EXPLANATIONS**

Claims 1-50 lack industrial applicability as defined by PCT Article 33(4).

Claims 1-50 are drawn to methods of production and methods of generating for characterization an organic molecule having "a desired property." The description does not disclose a method in which a desired property is produced. The description merely discloses a method which produces arbitrary peptides having arbitrary DNA cleavage activity of an unknown specificity on an arbitrary substrate (description pages 49-56). There is no industrial applicability disclosed for a method which produces these arbitrary products.

The description does not enable a method of producing organic molecules having a desired property but merely enables a method of detecting an arbitrary nuclease activity. A polypeptide and oligonucleotide are isolated and purified by a "logarithmic dilution" procedure. However, there is not way to direct this process and so the process results in producing an arbitrary nuclease activity. An arbitrary nuclease activity is not "desired." On the contrary, nuclease activity is often an undesired contaminant of biochemical preparations. Examples of desired nucleases are 5' to 3' exonucleases free of any other activity and site specific restriction endonucleases.

In order to establish whether the disclosed nuclease activity has a "desired property" one must purify the polypeptide by the tedious "logarithmic dilution" procedure, and test the polypeptide on various substrates. If, upon further testing, the polypeptide does not have the desired properties, then the whole process, including the tedious "logarithmic dilution," must be repeated over and over again with no guarantee that a "desired" exonuclease activity will ever arise.

Claims 1-50 met the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest the claimed methods.

\_\_\_\_\_ NEW CITATIONS \_\_\_\_\_  
NONE

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

United States Patent and Trademark  
Office  
(Box PCT)  
Washington D.C. 20231  
United States of America

in its capacity as elected Office

Date of mailing:

23 January 1995 (23.01.95)

International application No.:

PCT/US94/04314

Applicant's or agent's file reference:

2860/18

International filing date:

19 April 1994 (19.04.94)

Priority date:

19 April 1993 (19.04.93)

Applicant:

KAUFFMAN, Stuart, A. et al

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

21 November 1994 (21.11.94)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer:

M.C. Taylor

Telephone No.: (41-22) 730.91.11

## INTERNATIONAL SEARCH REPORT

International application No.

US94/04314

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(5) : C12Q 1/68; C12P 19/34, 21/00; C12N 15/63

US CL : 435/6, 188.5, 252.4

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 435/6, 188.5, 252.4

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,968,619 (CURTIS, III) 06 November 1990, see entire document.	1-50
Y	KEETON, "BIOLOGICAL SCIENCE" published 1980 by W. W. Norton & Company (N.Y.), pages 893-897, see entire document.	1-50

☐

Further documents are listed in the continuation of Box C.

☐

See patent family annex.

* Special categories of cited documents:		*T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
*A*	document defining the general state of the art which is not considered to be of particular relevance	*X*	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
*E*	earlier document published on or after the international filing date	*Y*	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
*L*	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Z*	document member of the same patent family
*O*	document referring to an oral disclosure, use, exhibition or other means		
*P*	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

25 JUNE 1994

Date of mailing of the international search report

25 JUL 1994

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

SCOTT HOUTTEMAN

Telephone No. (703) 308-0196

537,736

5650

From the INTERNATIONAL BUREAU

## PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

To:

RAYMER, Gregory, P.  
Willian, Brinks, Hofer, Gilson  
& Lione  
NBC Tower, Suite 3600  
455 North Cityfront Plaza Drive  
Chicago, IL 60611  
ETATS-UNIS D'AMERIQUE

Date of mailing 29 September 1994 (day/month/year) (29.09.94)	
Applicant's or agent's file reference 2860/18	IMPORTANT NOTIFICATION
International application No. PCT/US94/04314	International filing date (day/month/year) 19 April 1994 (19.04.94)

## 1. The following indications appeared on record concerning:

☒ the applicant    ☐ the inventor    ☐ the agent    ☐ the common representative

## Name and Address

KAUFFMAN, Stuart, A.  
1660 Old Pecos Trail  
Suite A  
Santa Fe, NM 87501-4768  
UNITED STATES OF AMERICA

## State of Nationality

US

## State of Residence

US

Telephone No.

Facsimile No.

Teleprinter No.

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☒ the person    ☐ the name    ☐ the address    ☐ the nationality    ☐ the residence

## Name and Address

REBEK, Julius, Jr.  
100 Memorial Drive  
Apt. 5-3A  
Cambridge, MA

## State of Nationality

US

## State of Residence

US

Telephone No.

Facsimile No.

Teleprinter No.

## 3. Further observations, if necessary: The applicant indicated in Box No. 2 is a new applicant and inventor for the United States of America only.

## 4. A copy of this notification has been sent to:

☒ the receiving Office    ☒ the designated Offices concerned  
☐ the International Searching Authority    ☐ the elected Offices concerned  
☐ the International Preliminary Examining Authority    ☐ other:
The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

M.C. Taylor  
Telephone No. (41-22) 730.91.11